CONCEPT PAPER: Development and Utilization of Solar Energy Technology for Combatting Malnutrition in Developing Countries

by

Fred R. Barrett, PHD

Food Technology Branch
Office of International Cooperation
and Development
U.S. Department of Agriculture

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Utilization of Solar Box Cookers In Combatting
Malnutrition in Developing Countries

1. Summary of the Problem and Proposed Solution to it

A. The Problem

There are two related problems that impact on the nutritional status of the poor and rural people in developing countries which will be addressed by the proposed project. These problems are (1) the need for fuel saving techniques for cooking food that allow the preparation of nutritionally important food while at the same time reducing fuel use, and (2) a method to increase the availability of potable water at the home/village level to help reduce illness and malnutrition associated with the consumption of water of poor quality.

These problems have been magnified by the growing scarcity of locally available fuelwood and the high cost of fossil fuel and other forms of energy. The fuel problems are resulting in changed food habits and improperly cooked food each of which have serious negative impact on the nutritional status of the family. In addition, shortage of fuel results in the lack of adequate heat treatment of poor quality water prior to use. This neglect affects malnutrition through the occurrence of diarrheal episodes, infections, and parasites resulting from the use of such water.

The successful resolution of these two problems could play an important role in improving the nutritional status of the poor and rural segments of the populations in developing contries.

B. Proposed Solution to the Problem

The introduction and use of an oven-type solar box cooker (SBC) seems to offer a potential solution to helping overcome the above problems. The simple-to-build, inexpensive, easy-to-use, Kerr-Cole-type solar box

cooker has been used extensively for over 5 years, especially in the western US, for cooking a wide variety and varying quantities of food for individual family use and for group needs (10). These cookers can be constructed from inexpensive materials usually available in developing countries.

The solar box cooker is a well insulated chamber with a transparent top which passes direct and reflected solar energy into the chamber. The solar energy is absorbed as heat by the walls of the chamber and the cooking vessels which raises the temperature of the cooker sufficiently high to cook food and heat water. Several pots and/or containers of water or food can be used at one time. There is no need to reposition the cooker or to be in attendance during the time it is being used. The temperature of the chamber can reach 250-350°F depending on sun conditions and whether or not one chooses to reorient the cooker during use. The food and water are held at these temperatures until they reach internal temperatures of 180°-200°F. These temperatures are sufficient to cook food and to make baked products typical of the diet of people in the United States.

It has been demonstrated recently in preliminary studies (8) that it is possible to use a SBC to pasteurize contaminated water making it suitable for human consumption. This ability of the SBC to produce potable water combined with its ability to cook food using solar energy would make the introduction and use of a SBC a positive step toward solving these problems and helping to improve the nutritional status of people in developing countries.

II. Background

For years there has been a growing concern and increased problems with the reduced availability of fuelwood, the high cost of fossil fuels, deforestation and soil erosion. Development experts such as Dulansey (6), Carr (4), Tinker (13) and others have cited these problems with fuelwood and other fuels as major problems in developing countries which are detrimental to family health and nutritional status and serve as a special burden for women. For example, in rural India women may walk

for two to three hours daily in search of dried wood or other sources of fuel. Even higher time estimates have been made for Tanzania and other countries. Also, in some cases up to 10-15 percent of the family food money is spent for fuel. Information from a study done in Burundi by CRS indicate that per day fuel costs could be about US$ 0.69 for charcoal or US$ 0.35 for peat when used under typical cooking conditions. Daily income was not available.

The result is that rural and low income people in developing countries often are without fuel due to the scarcity of fuelwood or to the lack of money with which to buy it. The shortage of fuel could lead to reduction in the nutritional status of people through changes in diets and cooking habits and through peripheral conditions related to malnutrition such as diarrheal episodes and infections resulting from the use of water of poor quality which has not been properly heated. These situations emphasize the need for new renewable energy technologis that are practical and useful at the home/village level in developing countries.

A. Fuel Problems in Food Preparation

Fuel is an essential commodity just as is food. It seems inevitable that the problems associated with the availability and cost of fuels will be with us and even intensify in the foreseeable future. It has been estimated that some two billion people continue to rely on non-commercial energy sources to cook, process food, heat water, etc. around the world. These sources of fuel include brush, wood, agricultural residues and animal dung.

Results from surveys carried out by CARE (14) in six developing countries regarding rural food habits showed that the pattern of selection and frequency of consumption of nutritionally important foods in the diet such as legumes were directly affected by fuel (energy) considerations. Similar situations have been found for other developing countries and were discussed at the First Asian Household Nutrition Appropriate Technology Conference (7). These discussions related to changes in food habits that are taking place which result in reduced consumption

of foods with longer cooking times, and in some cases fewer meals per day being prepared. These changes generally result in a reduced consumption of legumes which usually represent the major source of concentrated protein in the diet.

An example of a food preparation problem associated with fuel scarcity is in the school lunch feeding program in Kenya. Food is available to the schools for use in the mid-day meal for students. A major problem in implementing the program in certain sections of the country is the unavailability of fuel with which to prepare the food. This is due both to the shortage of local fuel and to the cost and difficulty of transporting other fuels to the schools. The consequence being that the foods are not prepared and the expected meals are not received by the stdents. It seems certain that other developing countries are faced with these same problems and would benefit from technologies that would use other sources of energy such as solar energy to provide heat for the cooking of food.

B. Improving Quality of Water

A problem associated with malnutrition is the occurence of diarrhea and the presence of water-borne infections and parasitic diseases. These conditions often are caused by the consumption of water of poor quality or of food which is prepared using water of poor quality. It has been estimated that from 1/2 - 1 billion episodes of diarrhea occur yearly in developing countries among children under five years of age. About five million deaths are directly attributed to these cases of diarrhea. The consequence of an episode of diarrhea is increased protein-energy malnutrition in the affected person and especially in children who are marginally fed.

Intestinal parasites may consume up to 25 percent of the dietary intake of infected people in developing countries. Many of the causative agents for these diseases and physiological conditions are waterborne or related to poor quality water. The incidence of intestinal parasites and gastrointestinal diseases could be reduced through the increased availability of potable water in addition to improvements in sanitation and hygiene.

One of the most important ways to improve health (and nutritional status) in village people is to help provide safe water free from organisms that cause dysentery, typhoid and other diseases. Water that looks clean may have disease germs in it. Unless water comes from a source that has been tested and found safe it should be boiled or treated in some other way to make it safe. (2)

The CARE report (14) cited earlier stated that boiling water for drinking is practiced more in Latin American countries than in other countries of the world. The principal reasons given in the other countries for not boiling water prior to consumption were (a) not customary to do so, (b) not necessary to do so, (c) requires fuel that is neither available nor affordable, and (d) it takes time to do. This was corroborated at the First Asian Household Nutrition Appropriate Technology Conference (7). Discussions there pointed out that the disinfecting of water by boiling is important but in many instances it is not done when needed because it requires considerable amounts of fuel and involves conscious effort and time to do it properly.

The reasons stated above about fuel and time requirement could be negated by the availability of a method using renewable energy which is affordable and which would produce potable water for drinking purposes and for food preparation without the expenditure of fuel (money) and time.

A special need for the availability of potable water is in the preparation and use of the Oral Rehydration Solution (ORS) for the treatment of diarrhea. Many people are concerned about the potential risk of using unsafe water in the solution thereby increasing the severity and/or duration of the diarrheal condition.

Discussions with personnel of the Water and Sanitation for Health (WASH) project confirmed that the standard answer for improving the quality of water at the home/village level is to boil it using whatever fuel is available. After discussion about the potential of the SBC to improve water quality these personnel encouraged that the proposed work be carried out as it was an interesting and unique idea worth trying and if successful, could be very valuable.

C. Solar Devices

In the 1960's solar cooking devices were being developed which the designers hoped would provide the needed renewable energy technology. The two major types were (a) parabolic-concentrator cooker developed at the University of Wisconsin (5) and (b) the slant-faced cooker developed by Telkes (12). These cookers were developed with design requirements that the cooker deliver heat (energy) levels comparable to an electric oven and reach and sustain temperatures of 450°F or more. Although subjected to various laboratory and field tests, solar cookers never were accepted for regular cooking or baking. Problems associated with the early cookers were that they were too large, too complicated, limited to only one cooking vessel at a time, expensive and required frequent attention during use. The need for full sun and frequent repositioning were big deterrents to the use of the parabolic-concentrator type of cookers. The slant-faced cookers with multiple mirror surfaces were of heavy metal construction and were bulky and quite expensive.

In addition to solar cookers, solar stills have been developed to produce distilled water. These devices generally are big, difficult to build and use and require considerable energy to produce relatively small amounts of water that is at a level of purity beyond that needed.

Literature searches related to the use of solar devices for cooking food and treating water were obtained from S&T/DIU, the National Technical Information Center and the National Agriculture Library. This information along with other reading resulted in only three major references to the development and use of solar box (oven) cookers. These

references included work with solar-ovens that was centered on the design and engineering aspects and not on applications. The cooking of food was referred to in a general way and nothing was included about heating water to improve its quality for human consumption.

Contact with personnel in S&T/Energy and AFR/Energy and with others working in Appropriate Technology revealed that they are not involved with solar ovens of the box cooker type. Discussions with VITA personnel indicated their interest in solar oven design which is concentrated on testing different insulating materials but is not concerned with cooking or on the microbiological aspects of food or water quality. Our interest in the use of SBC's for cooking and water treatment was discussed and they stated that it was something that needs to be done and would be of value.

We know of no work being done regarding the cooking and water treatment abilities of solar box cookers that have application in developing countries.

III. Program for Utilization of Solar Box Cookers

A. Purpose of Program

A program is proposed that would (1) assist in the development of the use of SBC's to meet the needs described for fuel saving methods of cooking food and for improving the quality of water in developing countries and (2) establish the mechanism for providing technical assistance for the utilization of SBCs in projects being carried out in the home and village setting in developing countries.

The program would be carried-out in three phases:
1. Operational Development, 2. Technology transfer - Pilot study,
3. Field trial.

B. Operational Development

The capabilities thus far demonstrated for cooking food and for treating water in a SBC appear to offer a viable alternative to help overcome the stated problems related to malnutrition. However, additional

development work is needed to establish operating conditions for a SBC for cooking various foods and for water quality improvement under conditions encountered in developing countries.

Testing needs to be carried-out with a SBC for cooking beans, corn, porridges and other foods commonly used in developing countries. This testing is needed to establish the ability of a SBC to properly cook such foods as to be acceptable to the expected users in LDC's.

Also, in the case of water quality improvement, testing needs to be carried-out on water containing the types and quantities of micro-organisms that are present and represent public health hazards in developing countries.

We propose that the operational development work be completed through a Cooperative Agreement with the Foundation of California State University-Sacramento (FCSUS). The Agreement will provide the services of Dr. Robert H. Metcalf of California State University, Sacramento (CSUS) who has used a SBC extensively over the past five years to cook foods of all kinds under widely varying conditions. Recently he directed a Master's Program which included the study of the ability of the SBC to improve the quality of contaimnated water to make it suitable for human consumption. The resulting Master's Thesis (8) represents the only known work using a SBC both for cooking and for water improvement. Dr. Metcalf has been involved with the introduction of SBCs to several developing countries through private individuals and through the Foster Parents Plan.

In addition, the Agreement will make available through the Foundation, trained personnel and facilities needed to carry-out the work. (see attached draft of proposed Cooperative Agreement).

The following procedures will be followed in order to obtain the objectives of the Agreement.

1. Heat contaimnated water in a SBC under a variety of weather condition, for different times, in various types of vessels and conduct micorbiological tests on the heated water to determine the disinfecting

ability of each treatment. The contaminated water will contain types and quantities of pathogenic micro-organisms associated with contaminated water in developing countries. The test organisms will include the usual indicator organisms and other micro-organisms of public health significance such as salmonella, Giardia, coliform, rotavirus, and fecal strep.

2. Carry out cooking tests under a variety of weather conditions on a variety of food items common in developing countries. The tests will determine the operating conditions needed to achieve a satisfactory level of doneness and to eliminate any public health hazards related to the preparation and consumption of the foods. This could include intentional treatment of foods with contaminated water to determine the extent of effectiveness of the cooking cycle. Foods to be tested include rice, corn, beans, and various types of porridge.

3. Complete testing of a SBC when loaded both with water and food to determine the disinfecting and cooking abilities under load.

4. Compile and evaluate all data collected and develop guidelines for the operation of a SBC to produce potable water and to adequately cook the test foods to the requirements set under various weather conditions.

Successful completion of the operational development work will be followed by a pilot study for transferring the technology to a developing country.

Specific details on the course of action for the pilot study and field test are not developed at this time. They will be done when the information needed from the preceeding phase become available.

C. Technology Transfer

The technology for using a SBC for cooking and for water treatment will be transferred to developing countries through a pilot study. A country will be selected that has conditions conducive to the use of SBC's and which has fuel and water quality problems. The study will intorduce SBC's to one or more homes in one or more villages to demonstrate their use in a real world situation.

The pilot study will be carried out through collaborative planning with USAID missions, host country organizations, local people and intended recipients. The study may be integrated into an ongoing rural development or nutrition program or be the basis for a new renewable energy technology program. It will include providing a SBC to project participants plus demonstration and training regarding the use of the SBC for cooking and water treatment. Data would be collected on technological and economic factors followed by an evaluation of the suitability of the technology and its degree of acceptance.

D. Field Test

A positive evaluation of the pilot study will be followed by a field test within the project country. The field test will include expanded distribution and use of SBC's. It will include the development of village industries to produce parts, kits, and assembled SBC's. Also there will be extensive dissemination of information on the availability and use of SBC's.

IV. Completion of Program

After completion of the three phases of this program, the following results are expected.

1. The development and demonstration of the utility of a SBC for the preparation of food and for improving the quality of water.
2. Pilot studies to demonstrate the feasibility of using a SBC for food preparation and water treatment at the home and village level in developing countries.
3. Designs for programs utilizing a SBC in village/institutional food preparation and water treatment.
4. Use of solar box cookers for cooking food and the treatment of water in one or more developing countries.
5. One or more village level industries to produce component parts, kits and assembled SBCs.
6. The development of an institutional source of solar (energy) cooker expertise that can be used in additional program implementation in developing countries.

V. Benefits from Program

Successful completion of the program could result in the following benefits to people in developing countries.

1. Considerable saving in the use of fuelwood from severely dwindling sources or of other types of fuels.
2. Savings in household money now used to purchase fuel could be used to purchase more/better food for the family diet.
3. Time freed from fuelwood collection could be used in gainful employment to increase the family income.
4. Increased available time could be devoted to increasing food production for family consumption.
5. More time could be spent in the preparation of food and care of the children
6. Inclusion of beans or other more nutritious food into the diet excluded due to energy use reasons.
7. The preparation of potable water without the use of traditional fuels.
8. A reduction in diarrheal episodes with subsequently less harm to the nutritional status of the affected.
9. Reduced exposure to water borne diseases and parasites by removal of the causative agents from the water.

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